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schools, in orphan asylums, and in the various other institutions. Among adults, those who come in contact with diphtheria and are constantly exposed and in danger should also be tested and immunized with toxin-antitoxin if found to give a positive Schick reaction. Included in this group are especially physicians, nurses, and hospital attendants in contagious disease hospitals.

2. *To control an outbreak of diphtheria.*—As the immunity arising from an injection of toxin-antitoxin does not develop until the lapse of from 2 to 12 weeks, active immunization can not be utilized to protect persons from exposure within that period. In institutions, however, where small outbreaks of diphtheria have occurred, or where diphtheria is more or less constantly present and clinical cases and bacillus carriers steadily appear, the use of antitoxin alone has often been insufficient to stamp out the disease, but the combined application of the Schick test and active immunization with toxin-antitoxin has given successful and encouraging results. Toxin-antitoxin immunization should not be used with antitoxin immunization in the same individual, as the surplus antitoxin tends to prevent the development of an active immunity.

BIOCHEMICAL STUDIES OF THE SALIVA IN PELLAGRA.

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It is well established that in pellagra the alimentary tract is involved. Of the digestive tract, the oral cavity is of considerable importance in the diagnosis of pellagra, since the condition of the tongue is of much significance. The true pellagra tongue is vividly red and more or less swollen. Other parts of the oral cavity are likewise involved.

Since the oral cavity is of importance in the diagnosis of pellagra, a reconnoissance survey of the mixed saliva of individual pellagrins was started to determine wherein, if at all, the saliva, from a biochemical standpoint, differs from that of normal individuals. The study of the saliva included the rate of flow, the specific gravity, the total solids, the ash, the diastatic power, mucin, sulphocyanate, and abnormal constituents such as urea, uric acid, phenols, and indican.

The patients were inmates of the pellagra hospital of the United States Public Health Service at Spartanburg, S. C. Cases of pellagra reported by the medical staff as uncomplicated were taken for study. The work began April 12, 1917, and continued to June 19, and covered all practically uncomplicated cases of pellagra in the hospital during that period. During the time the saliva study was going on, only six of the patients, cases 294, 297, 303, 325, 327, and 338 were considered severe cases of pellagra; the rest were mild cases, or were improving rapidly. The patients were on a fixed ration, and the actual consumption within the ration was carefully recorded from day to day. Barring complicating ailments, the treatment in the hospital was altogether dietary.

With one or two exceptions where special diets were used, the rations employed were diets F, G, or B. On admission, the patients, as a rule, were placed on diet G or F and, subsequently, on diet B. These diets were as follows:

Food.	Diet F.	Diet G.	Diet B.
	Grams.	*Grams.*	*Grams.*
Beef	100	100	100
Milk	cc. 400	cc. 400	cc. 1,000
Egg	....	....	100
Ham	25	25	....
Wheat bread	300	300	300
Butter	45	45	45
Orange juice	cc. 50	cc. 50	cc. 50
Irish potato	100	100	150
Mush	50	50	50
Grits	50	50	....
Turnip tops, spinach, collards, or cabbage	50	50	....
Beets or turnips	50	50	....
Prunes or apples	60	50	50
Black-eyed field pea	50	....	....
Pork fat	20	....	....
Sugar	20	20	20
Coffee	cc. 150	cc. 150	cc. 150

When possible, the saliva was collected shortly after the patient had entered the hospital, and then once or twice a week until June 19. In some cases considerable time elapsed between the admission of the patient and the taking of the first sample of saliva. This delay was due either to the patient's condition or to the nondetermination as to whether or not there were complicating ailments. Three of the hospital staff served as controls.

The rate of flow was determined by the time (in minutes) required to deliver 50 cc. of saliva; the total solids by drying to constant weight at 100° C.; the ash, in the customary way, in platinum; the mucin, by precipitating with 1 per cent acetic acid; the sulphocyanate, by 5 per cent ferric chloride and 1 per cent hydrochloric acid in the spot plate and in test tubes, and in selected cases by the Rupp and Schied,[1] Thiel,[2] iodometric method; phenol and uric acid by Folin and Denis's[3] phenol and uric acid reagents; indican by means of Obermayer's reagent; the diastatic power by determining gravimetrically by Fehling's solution, the sugar formed by 1 cc. of saliva acting on 25 cc. of a 1 per cent starch paste at 50° C. for 15 minutes. In view of the fact that Hunter, Givens, and Lewis[4] found that 52 per cent of the patients studied by them showed an entire absence of free HCl in the gastric contents, the question as to whether or not the diastatic power of the saliva was lacking became of greater interest.

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[1] Berichte d. d. chem. Gesell. XXXV, 2191, 1902.

[2] Ibidem, 2766.

[3] Jour. Biol. Chem. 12, 239, 1912.

[4] Bull. 102, Part II. Hygienic Laboratory, U. S. P. H. S., Treasury Department, 1916.

Rate of flow.

The rate of flow was determined under the stimulus of chewing paraffin. In order to avoid any effect that the taking of food might have on the rate or the constituents of the saliva, all collections were made between 10 and 11 a. m., or from three to three and one-half hours after breakfast and from one to two hours before the midday meal. Before beginning the collection of the saliva, the mouth and teeth were washed with a small amount of water and also with the first few cc. of saliva formed under the stimulus of chewing paraffin. The rate of flow was found to vary greatly from individual to individual, and even in the same individual from time to time.

Leaving out of consideration case 296, who had a very scanty flow—practically none—the rate of flow of 38 hospital patients at the start of the testing varied from 10 to 126 minutes, with an average of 29.9 minutes. Leaving out case 525, who was in a weak condition, and required 63 minutes to give 25 cc., or 126 minutes (estimated) to give 50 cc., the average for 37 patients for the first test made in each case was 27.4 minutes. Of the 13 cases under study for at least three weeks, with more or less improvement in general health, the rate of flow varied from 13 to 39 minutes for 50 cc., with an average of 26.5 minutes. The rate of flow of eight normal people, as determined by 57 tests, made from 1 to 17 times on the individual, was found to vary from 14 to 50 minutes, with an average of 26.6 minutes.

The pellagrins may be grouped into two classes: (*a*) Those who had more or less soreness of the mouth and tongue at the time the first test was made, and (*b*) those who, irrespective of a previous history of such symptoms, had no mouth symptoms at the time of testing. In the 15 cases with mouth symptoms, the rate varied from 10 to 35 minutes, with an average of 21.7 minutes. In the 23 cases with no mouth symptoms, the rate varied from 15 to 126 minutes, with an average of 35.2 minutes. Four of the cases with definite tongue and mouth symptoms (cases 297, 300, 323, and 332) gave 50 cc. in 10, 12, 12, and 14 minutes, respectively. One case, number 298, with no history of mouth symptoms, gave 50 cc. of a grayish, viscous saliva in 15 minutes. In general, however, it would seem that the quantity of saliva secreted is increased at the time the tongue and mouth are involved. The relation between the rapid rate of flow and soreness of the tongue and mouth is brought out clearly by case 303. On April 20, one day after admission to the hospital, the tongue, though thickened, was not sore; nor was the mouth. The rate of flow was 27 minutes. On May 1 and May 4, the tongue was red and sore, and the rate of flow was 13 minutes and 15 minutes, respectively. On June 5, the tongue was normal and the rate was 22 minutes for 50 cc. The connection between a sore, over-red tongue and the rate of flow is not as definite, however, as it might be, for cases were found (such as case 300) where the rapid rate of flow persisted long after the mouth symptoms had disappeared. Again, the patient may have tongue and mouth symptoms with a fairly slow rate of flow, as obtained in cases 294 and 327 where 35 and 34 minutes, respectively, were required to deliver 50 cc. Leaving out the four cases with mouth symptoms and very rapid flow, the average for the other 11 cases with sore mouth was 25.3 minutes for 50 cc.

Considering the great variation in the flow of the saliva in normal people, the study of the salivary flow in the cases of pellagra at this hospital simply warrants the conclusion that, in general, the rate of flow of the cases studied varies on the whole within normal limits. In occasional cases, with mouth symptoms, the flow may be abnormally fast. In other cases, it may be abnormally slow.

The saliva of many of the pellagrins was more turbid, more ropy, and more viscous than that of the controls—suggestive of sympathetic saliva described by Schulz.[1] With improvement in the general condition of the patient, the ropy, or viscous quality of the mixed saliva became less marked. Since the rate of flow as determined by the time to give a definite amount of saliva did not agree with the patient's belief that there was an increased amount of saliva in the mouth or with the observer's judgment on this point from the amount of spitting made by the patient, the conclusion must be drawn that the salivation spoken of in the literature as occurring in pellagra is not always a true salivation with a greater volume of saliva, but, rather, is often an apparent salivation due to some inhibition of swallowing combined with a physical change in the saliva from a nonropy, or slightly ropy, thin flowing type such as occurs in normal people to a more ropy kind which makes the presence of saliva in the buccal cavity more obvious.

The Specific Gravity of the Mixed Saliva in Pellagra.

According to Hammarsten and Hedin,[2] the specific gravity of mixed saliva varies from 1.002 to 1.008. According to Fleckseder[3] the clear saliva varies from 1.0025 to 1.004. The specific gravity of the unfiltered saliva of the controls as determined here by means of a Boot vacuum space specific gravity bottle was found to vary from 1.0019 to 1.0039, with an average for a month's testing of 1.0029. The determination of the specific gravity was made immediately after the saliva was collected.

The variation for 22 cases of pellagra in which the specific gravity was determined was from 1.0024 to 1.0078 with an average for all determinations of 1.004. As compared with the controls, the specific gravity of the saliva of pellagrins tends to be slightly higher, but still within normal limits.

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[1] C. Oppenheimer. Handbuch der Biochemie des Menschen und der Tiere. III, I, 44, 1910.

[2] A Textbook of Physiological Chemistry, 8th ed., translated by Mandel, 1915, 455.

[3] *Zeitschrift f.* Heilkunde, Abtheil f. interne Medizin 7, 230, 1906.

The Total Solids of the Saliva in Pellagra.

The dry matter of mixed human saliva, according to Schulz [1] varies from 0.5 to 1 per cent or between 5 and 10 parts per thousand. The average of the first determination for the controls was 4.79 parts per thousand. The average of the first determinations for the pellagrins was 6.79 parts per thousand. The average for those with mouth symptoms was 6.70 parts per thousand; of those without mouth symptoms, 6.88 parts per thousand. The average of three controls for 16 distinct sets of analyses over a period of two months was 5.05 parts per thousand; of 22 pellagrins, 6,67 parts per thousand. The total solids of the saliva of four pellagrins were the same as, or only slightly above, that of the three controls. Of the other 18 cases the average total solids were 6.97 parts per thousand. The saliva of pellagrins, then, had a tendency toward a greater quantity of total solids than the saliva of the controls had. From the beginning of the experiment to the end no rule was observed in the increase, or decrease, in the total solids, so food changes played little part.

The Ash of the Saliva.

The ash of the controls at the beginning of the experiment was 2.4, 2, and 2.3 parts per thousand. The ash of one pellagrin who had been in the hospital four months and showed but slight, if any, evidence of pellagra, was 2.3 parts per thousand. Three other of the pellagrins showed 2.4, 2.4, and 2.6 parts per thousand, respectively. In the other 18 cases of pellagra studied in the hospital, the ash was higher than it was in the controls, and varied from 3.2 to 5.1, with an average of 3.63 parts per thousand. Taking all cases, the average of the first determination is practically the same for those with mouth symptoms as for those without—3.4 and 3.25 parts per thousand, respectively. Throughout the experiment the saliva of the hospital patients tended to have a higher ash content than the saliva of the controls. The average of the controls for 13–14 determinations over a period of two months was 2.68 parts per thousand. The individual averages of the pellagrins in from 3 to 11 determinations varied from 2.31 to 4.75 parts per thousand, with a general average of 3.48 parts per thousand.

Organic Matter of the Saliva.

The difference between the total solids and ash was called organic matter. The variation in the controls for the first determination was from 2.19 to 2.97 parts per thousand, with an average of 2.69. The organic matter of the saliva of 22 pellagrins in the first determination varied from 1.63 to 5.72 parts per thousand, with an average of 3.39. The average of all determinations during the two months was 2.37 parts per thousand for the controls, 3.19 parts per thousand for the hospital patients.

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[1] Handbuch der Biochemie des Meuschen und der Tiere. Oppenheimer 111, Theil 1, 27, 1910.

The Diastatic Power of the Saliva in Pellagra.

The diastatic power was measured by determining the quantity of sugar formed by 1 cc. of natural mixed saliva acting upon 25 cc. of starch paste for 14 minutes. The starch paste was made by stirring cornstarch with cold water, adding the mixture to boiling water while stirring, boiling for two minutes, and cooling in an ice box for a time and then at room temperature. Then the volume was made such that 100 cc. of the paste contained 1 gram of starch.

Evans[1] considers that for salivary amylase the optimum concentration of starch is about 3 per cent and the optimum temperature 46° C. The reaction, he says, comes to equilibrium when 81 per cent of the starch has been converted to maltose. Kjeldahl, referred to and verified by Fleckseder,[2] found that with 0.5 to 2 cc. of saliva acting on 100 cc. of a 1 per cent starch paste for 15 minutes, the amount of reducing sugar formed is directly proportional to the amount of active amylase. According to Slosse and Limbosch[3] the rate of digestion by ptyalin increases from 40° C. to 58° C., and then rapidly falls off. At 70° C. it is stopped altogether.

In our work 25 cc. of freshly made starch paste were placed in a 50 cc. beaker and brought to 50° C. in a water bath maintained at that temperature. Six beakers properly labeled with the case number or name were placed in the bath at a set. When the desired temperature, 50° C., had been secured, 1 cc. of the respective saliva was added at intervals of one minute. At the end of 14 minutes' digestion each beaker was placed on a hot plate and the contents of the beaker were brought rapidly to approximately 85° C. to destroy the sugar-forming enzyme. Precautions were taken to keep the conditions the same for each and every case. The digestion mixtures were allowed to cool and were then filtered through paper. The paper was then thoroughly washed and the volume of the filtrate and washings brought to exactly 50 cc. in volumetric flasks. The reducing power of 10 cc. of the solution was estimated gravimetrically, using Soxhlet's modification of Fehling's solution, with attention paid to details of preparation of solutions, asbestos mats, and time of boiling, as given in Bulletin 107 (revised), United States Department of Agriculture, 1908, pages 42, 241, and 242. The solutions of copper and alkaline tartrate were filtered through well-treated asbestos until clear, and were always freshly made. Fifteen cc. of the mixed

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[1] J. Physiol. 44, 191, 1912.

[2] Zeitschr. f. Heilkunde, Abtheil. f. interne Medizin. 7, 242, 1906.

[3] Arch. intern. Physiol. 6, 635; C. A. 2, 3238, 1908.

Fehling's solution were diluted to 30 cc., 10 cc. of the solution under examination added, the mixture brought to boiling in four minutes, boiled for two additional minutes, and filtered hot. The agreement between duplicates was close.

With these precautions the gravimetric Fehling method was found to give exact analysis with 1 per cent c. p. dextrose solution. The reducing power of 1 cc. of saliva was found to be negligible. Twenty-five cc. of the starch paste was treated in the same way as the saliva starch-paste mixture, and the reducing power of the clear filtrate determined. The reducing power of the 25 cc. of starch paste varied from 0 to 0.010, with an average of 0.002 grams of Cu_2O.

The results given in Table I in terms of cuprous oxide precipitated from the Fehling's solution show that there is great variation in the diastatic power from individual to individual and in the same individual from time to time. In this respect the controls vary as well as the pellagrins. The conclusion can be drawn, however, that the diastatic power of the saliva of pellagrins is at least as great as that of normal people. Mouth symptoms, such as sore or highly reddened tongue, or burning in the buccal cavity, cause no consistent variation in the diastatic power of the saliva. In no case, whether the flow was very scanty or very copious, was the diastatic power lacking.

TABLE I.—*Diastatic power of 1 cc. of saliva in mgs. of Cu_2O.*

Case.	Date admitted.	Condition at start of experiment.	Date of test.									Average.
			Apr. 12.	Apr. 16.	Apr. 20.	Apr. 24.	May 8.	May 22.	May 29.	June 5.	June 19.	
Control 1			172	98	182	137	121	143	148	.....	113	139.3
Control 2			148	135	187	133	168	157	173	140	160	155.6
Control 3			172	286	185	129	149	150	159	130	.....	170.0
270	Oct. 25, 1916	Mild	158	203	.....	.....	.....	.....	.....	.....	.....	180.5
281	Dec. 5, 1916	do	168	203	203	149	166	182	196	121	.....	174.0
294	Apr. 3, 1917	Severe; sl. M. S.[1]	177	162	183	.....	.....	.....	.....	.....	.....	174.0
297	Apr. 11, 1917	Severe; M. M. S.[2]	147	175	165	161	134	79	.....	.....	.....	143.5
298	Apr. 12, 1917	Mild	.....	191	179	250	154	176	.....	.....	.....	190.0
303	Apr. 19, 1917	Severe; M. M. S.[2]	.....	.....	181	153	170	150	130	111	.....	149.2
301	Apr. 16, 1917	Mild	.....	.....	199	180	181	195	.....	.....	.....	188.8
300	do	Mild; sl. M. S.[1]	.....	.....	.....	162	145	183	.....	144	143	155.4
307	Apr. 25, 1917	Mild	.....	.....	.....	.....	176	184	177	101	.....	159.5
313	May 2, 1917	do	.....	.....	.....	.....	.....	204	126	89	.....	139.7
302	Apr. 18, 1917	do	.....	.....	.....	.....	.....	197	156	.....	.....	176.5
304	Apr. 20, 1917	do	.....	.....	.....	.....	.....	166	.....	.....	.....	166.0
318	May 2, 1917	do	.....	.....	.....	.....	.....	182	164	135	157	159.5
312	May 1, 1917	do	.....	.....	.....	.....	.....	237	244	228	121	207.5
309	Apr. 30, 1917	Mild; sl. M. S.[1]	.....	.....	.....	.....	.....	218	179	159	.....	185.3
299	Apr. 13, 1917	Mild	.....	.....	.....	.....	.....	211	150	175	.....	178.7
319	May 12, 1917	do	.....	.....	.....	.....	.....	221	157	151	156	171.3
323	May 22, 1917	Mild; sl. M. S.[1]	.....	.....	.....	.....	.....	213	83	114	116	131.5
327	May 27, 1917	Severe; M. M. S.[2]	.....	.....	.....	.....	.....	.....	158	164	148	156.7
325	May 26, 1917	Severe; sl. M. S.[1]	.....	.....	.....	.....	.....	.....	175	180	.....	177.5
326	May 27, 1917	Mild; sl. M. S.[1]	.....	.....	.....	.....	.....	.....	197	.....	.....	197.0
324	May 24, 1917	Mod.; M. M. S.[2]	.....	.....	.....	.....	.....	.....	163	206	91	153.3
332	June 4, 1917	Marked; sl. M. S.[1]	.....	.....	.....	.....	.....	.....	.....	215	124	169.5
330	June 2, 1917	Mild	.....	.....	.....	.....	.....	.....	.....	.....	169	169.0
339	June 15, 1917	Mild; sl. M. S.[1]	.....	.....	.....	.....	.....	.....	.....	.....	134	134.0
329	June 1, 1917	Mild	.....	.....	.....	.....	.....	.....	.....	.....	139	139.0
331	June 4, 1917	Mild; sl. M. S.[1]	.....	.....	.....	.....	.....	.....	.....	.....	147	147.0
322	May 20, 1917	Mild	.....	.....	.....	.....	.....	.....	.....	.....	154	154.0
333	June 6, 1917	Mild; sl. M. S.[1]	.....	.....	.....	.....	.....	.....	.....	.....	147	147.0
338	June 13, 1917	Severe; M. M. S.[2]	.....	.....	.....	.....	.....	.....	.....	.....	178	178.0

[1] Sl. M. S.=slight mouth symptoms.

[2] M. M. S.=marked mouth symptoms.

Simon,[1] using Violette's modification of Fehling's solution, found the salivary diastatic power lessened in cachetic and infectious diseases, and concluded that the diastatic activity of the saliva is decreased in disease. Salkowski,[2] referred to by Simon, found an increased diastatic power in a case of angina tonsillaris catarrhalis and also in salivation by mercury. Hatta[3] concluded that the salivary diastase did not seem to be directly influenced by the kind of food, and that it showed no characteristic fluctuation in any of the diseases studied. Purjesz,[4] likewise, could find no definite relationship between the amylolytic power of the saliva and diseased conditions outside the oral cavity. In pellagra, certainly, as judged by the hospital patients, it would seem that the diastatic power varies little from that of normal people. A number of the pellagrins gave a history of a relatively low protein, high carbohydrate diet on entrance to the hospital. The change to a relatively high protein diet in the hospital produced no consistent change in the rate of salivary digestion *in vitro*. This finding is an agreement with that of Carlson and Crittenden,[5] who found no evidence that, in man, even years of exclusion of meats and greatly increased carbohydrate in the food would appreciably increase the ptyalin concentration.

Mucin.

In the beginning of the saliva study mucin was precipitated by pouring 25 cc. of saliva into 100 cc. of 95 per cent alcohol. This method, however, was abandoned because it was concluded that the alcohol precipitated other matter than mucin. Accordingly, about three weeks after the start of the study of the saliva, mucin was precipitated by adding 25 cc. of saliva to 50 cc. of 1 per cent acetic acid. The average mucin precipitated from the saliva of three controls by this method varied in 9 to 10 determinations from 84.4 to 104.8 mgs. per 100 cc. with a general average of 91.7 mgs. The average mucin of the saliva of 21 hospital patients varied from 68 to 202 mgs. per 100 cc. with an average of 126 mgs. Only four of the cases were classed as severe cases of pellagra. Of these severe cases the mucin averaged 109.6 mgs. per 100 cc.

When the pellagrins were grouped into those who at the start of the testing, or during it, had some soreness of the mouth and tongue, and those who showed no mouth symptoms, it was found that the former group averaged 115.3 mgs. per 100 cc., while the latter averaged 132.4 mgs. The mucin precipitated from saliva by dilute acetic acid is, then, greater for the saliva of pellagrins than for the controls, but the increased amount of mucin is not tied up with the severity of the general pellagra symptoms or with the mouth symptoms.

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[1] J. Physiol. path. gén. 9, 261, 1907.

[2] Virchow's Archiv. CIX, 35, 1887.

[3] Jour. Amer. Med. Assoc. 66, 930, 1916.

[4] Wien. klin. Wochschr. 26, 1307, 1914.

[5] Proc. Soc. Exp. Biol. Med. 7, 52, 1909-10.

Sulphocyanates.

Sulphocyanate is an almost constant constituent of human saliva. In starting the study of the sulphocyanates, it was intended to make use of the iodometric method utilized by Rupp and Schied[1] and improved by Thiel,[2] a quantitative method which Gies and his collaborators[3] found very satisfactory. On making qualitative tests with the salivas with ferric chloride, followed by dilute hydrochloric acid, it was found that the saliva of normal people gave a striking pink or blood-red color with the reagents, while the saliva of the pellagra patients gave a slight yellow, or barely perceptible shade of pink.

The striking contrast of the saliva of pellagrins with that of normal people in the reaction with the ferric chloride brought us to the conclusion that this test would allow us to test out the sulphocyanate reaction in a great many cases and to decide definitely whether or not sulphocyanate is, in general, decreased in pellagra. By the ferric-chloride hydrochloric-acid test on the spot plate the senior author found it possible to detect very readily the presence of 0.4 mgs. of potassium sulphocyanate in 100 cc. of distilled water or saliva, so that it is certain that a saliva which gives no reddish shade of color with the ferric chloride and hydrochloric acid on the spot plate has less than 0.0004 per cent of sulphocyanate calculated as potassium sulphocyanate.

By means of test tubes and color comparison with water, ferric chloride, and hydrochloric acid, 0.000025 per cent or one part of potassium sulphocyanate can be detected in 4,000,000 parts of distilled water, as Perlzweig and Gies[4] claim.

It was intended to make as many tests as possible with the qualitative and roughly quantitative ferric chloride and hydrochloric acid reagents to determine whether or not the saliva of pellagrins is predominantly lacking in sulphocyanate as compared with nonpellagrins and then to utilize the precise Rupp-Schied-Thiel method to make a quantitative expression of the difference between the saliva of pellagrins and that of normal people. As stated above, however, the contrast between the reaction of the saliva of pellagrins and that of normal people was found so striking that the ferric chloride-hydrochloric acid test alone was employed for the comparison.[5]

A small amount of fresh saliva was placed in the cup of a porcelain spot plate, a drop or two of 5 per cent ferric chloride added, the mixture stirred with a drop or two of 2 per cent hydrochloric acid. Ferric chloride gives a red color with a number of substances, such as formic, acetic, diacetic, and certain phenolic acids, but not in acid solutions. Large amounts of organic acids, such as tartaric and lactic, may obscure the reaction with ferric chloride, but not small quantities in the presence of hydrochloric acid. To put it briefly, nothing other than sulphocyanate, which gives the red color with ferric chloride in the presence of hydrochloric acid, has ever been found in normal or pathological saliva. The addition of hydrochloric acid is necessary also, because, as found by the senior author, occasionally a saliva is found which will give no sulphocyanate color with ferric chloride until hydrochloric acid is added.

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[1] Berichte d. d. chem. Gesell. XXXV, 2191, 1902.

[2] Ibidem. 2766.

[3] Gies and Kahn, Dental Cosmos LV, 40, 1913. Gies, Lieb, and Kahn, ibidem. LVI, 175, 1914.

[4] Biochem. Bull. IV, 206, 1915.

[5] In a number of cases studied subsequently to the work detailed herein, the Rupp-Schied-Thiel method was used, and although the patients were well on the road to recovery and some were about to be discharged, the sulphocyanate content of the saliva was found, in general, less than in normal people.

In addition to the spot-plate method, the reaction with ferric chloride and hydrochloric acid was performed in small beakers and small test tubes. The test-tube method is the most delicate. By arranging a series of tubes containing from 200 parts per million to 1 part per million of potassium sulphocyanate, in gradations of 10 down to 10 parts per million and in gradations of 2 down from 10 parts to 1 part per million, the test can be made a rapid and, approximately, a quantitative test. The spot plate gives an idea of the standards to be used. To 5 cc. of several standards and to 5 cc. of the saliva, 0.5 cc. of a 5 per cent ferric chloride solution and 0.5 cc. of 1 per cent hydrochloric acid are added. By comparison with the standard sulphocyanate colors so developed, an approximate determination of the sulphocyanate calculated as the potassium salt can be arrived at.

Of 40 cases of pellagra, tested in the hospital, 32 gave no perceptible pink or red color with ferric chloride with or without the addition of hydrochloric acid; 4 gave only a faintly positive test such as given by 10 parts per million of sulphocyanate; and 4 gave a decidedly positive test varying, as judged by potassium sulphocyanate standards, from 20 parts per million to 90 parts per million. Of the patients giving a strong, positive reaction for sulphocyanate, cases 329 and 330 were mild cases of pellagra in well-nourished condition; case 322 had been in the hospital one month before the test was made, and was in good condition; while case 519 was a residual case of strong physique.

Of 50 normal people tested, male and female, black and white, members of the hospital staff, attendants, and visitors to the hospital, 46 were decidedly positive. Compared under similar conditions with freshly made standard colors, representing known concentrations of potassium sulphocyanate, the variation of the sulphocyanate of the saliva of 10 normals was from 20 parts to 160 parts per million with an average of 60 parts per million, or 0.006 per cent

Though but roughly quantitative, the study of the sulphocyanate by the reaction with ferric chloride and hydrochloric acid showed that, in general, the saliva of pellagrins contains a lessened amount of sulphocyanate than normal saliva does. Probably none of the salivas are absolutely free from sulphocyanate, since a number of salivas which gave but a faint tinge of orange on addition of ferric chloride and hydrochloric acid in test tubes gave a good red color with the reagents on concentrating to one-fifth, or more, of the original volume. The fact obtains, however, that the saliva of pellagrins contains much less sulphocyanate than the saliva of normal people.

Since it is generally admitted that the sulphocyanate arises from the metabolism of protein and the detoxicating action of the system whereby poisonous cyanides are converted into the relatively innocuous sulphocyanate[1] the explanation for lessened sulphocyanate in the saliva of the pellagra patients is believed to lie in a lessened protein intake and a detoxicating power feebler than normal. The senior author has found, in fact, that, in general, in pellagra the total nitrogen of the urine is much less than normal. That the low protein intake, or assimilation, is not the only explanation is readily shown by the fact that even on the fairly high protein diet in the hospital the salivary sulphocyanate of the patients is greatly less than normal, and further, one powerfully built, alert, and active normal person living on a generous protein diet rarely showed more than a trace of sulphocyanate in his saliva over a period of three months and in many tests. The question is still under study.

Phenols and Uric Acid.

The saliva of 3 controls and of 16 patients was tested twice over a week's interval with Folin and Denis's phenol reagent and uric acid reagent. All the saliva gave a more or less blue color with the phenol reagent. As determined by means of a Duboscq colorimeter, the phenol of the saliva of pellagrins was sometimes greater than normal, sometimes less. The color with the uric acid reagent was always slight, but much more evident for the saliva of the pellagra patients than for the three controls.

Indican.

While making a routine test of the urine of patients, Dr. C. H. Waring, assistant surgeon, found the urine of case 313 to be very high in indican. Accordingly, tests were made of the saliva by means of Obermayer's reagent and chloroform. Once the chloroform was blue with indigo blue and once red with indigo red. No other saliva showed the presence of appreciable amounts of indican. It may be noted that shortly after the discovery of indican in his saliva, case 313 was judged to be suffering from tuberculosis also, from which disease he died about a month later. What part the tuberculosis played in the presence of indican in the saliva can not be told.

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[1] For the pharmacological action of sulphocyanate see Gies, Lieb, and Kahn. Dental Cosmos LVI, 175, 1914.

Reaction of the Saliva.

Subsequent to ending the study of the saliva as outlined in the previous pages, the question of the reaction came up. Accordingly, the reaction was determined, using methyl orange and $\frac{n}{10}H_2SO_4$. All the available little complicated cases, 19 in number, in the hospital during the period July 19 to July 22 were utilized. The reaction varied from 0.07 to 0.23 per cent NA_2CO_3, with an average of all determinations for the four days of 0.14 per cent NA_2CO_3. For each case it was rather constant over the four days.

These patients had been in the hospital for periods varying from 3 to 54 days. The average alkalinity for seven patients who had been in the hospital less than a week was 0.154 per cent NA_2CO_3; for six patients under treatment from 9 to 22 days, 0.133 per cent NA_2CO_3; for six under treatment 25 to 54 days 0.135 per cent NA_2CO_3. It would seem that the hospital treatment, which was altogether dietary, had little effect on the reaction of the saliva.

Chittenden and Ely[1] give the alkalinity of normal saliva as 0.08 per cent NA_2CO_3, Chittenden and Smith[2] as 0.097, and Schlesinger[3] as 0.032 per cent. It is certain that the alkalinity of the saliva of the hospital patients is greater than that given by the authorities quoted. (A comparative study of the saliva of pellagrins and of normal persons is being made.) The data on the reaction is given in Table II.

TABLE II.—*Reaction of the saliva of pellagrins in percentage of sodium carbonate.*

Case.	Percentage of sodium carbonate.				Case average.	Days under treatment.
	July 19.	July 20.	July 21.	July 22.		
356	0.16	0.172	0.17	0.17	0.1655	5
344	.14	.136	.11	.13	.129	22
333	.11	.103	.14	.12	.118	43
328	.14	.160	.14	.15	.1475	51
337	.19	.172	.15	.17	.17	6
240	.15	.14	.13	.14	.14	22
357	.14	.14	.14	.14	.14	3
339	.12	.126	.13	.13	.1265	34
359	.09	.088	.09	.09	.09	3
338	.18	.176	.15	.17	.169	6
325	.20	.198	.18	.19	.192	54
351	.12	.118	.11	.12	.117	18
358	.12	.13	.13	.13	.1275	3
354	.11	.114	.10	.11	.1085	9
340	.15	.135	....	.14	.1416	33
347	.17	.146	.13	.15	.149	22
355	.21	.212	.23	.22	.218	6
349	.15	.162	.16	.14	.153	20
341	.10	.078	.07	.08	.082	25
Daily average	.145	.1424	.1361	.1416	.1413	......

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[1] Amer. Chem. Jour. IV, 329, 1882.

[2] Transact. Connecticut Acad. 6, 343, 1885.

[3] Virchows Arch. cxxv, 146, 340, 1891.

Summary.

The rate of flow of the saliva of patients at the Pellagra Hospital was found to be occasionally very rapid, occasionally very slow, but in general it was within normal limits.

The specific gravity of the saliva of pellagra patients tends to be higher than that of the controls.

The total solids, ash, organic matter, and mucin of the saliva are greater for the pellagrins than for the controls, but bear no relation to the mouth symptoms.

The diastatic power of the saliva of pellagrins varies within the limits established by the controls.

The sulphocyanate content is much less marked in the saliva of the pellagra patients than in that of normal people.

The reaction of the saliva in pellagra is somewhat more alkaline than is that of normal saliva.